Validating Ancient Way of Rainfall Prediction with the IMD Gridded Rainfall using Computational Methods over Indian Region

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Abstract:

The distribution and prediction of rainfall is very prominent for water management for agriculture. The weather prediction has been in practice since ancient times based on the changes in meteorological (wind and cloud patterns), biological and astrological (planetary positions). By making use of Indian Meteorological Department's rainfall data for the period 1985-2015, this study mainly compares and validates the ancient method of rainfall prediction particularly during the eclipse occurrence. By making use of the ancient Sanskrit texts available in the Bruhat Samhita five rules (rule1, rule2 rule3, rule4, rule5) related to the occurrence of rainfall over the Indian region during the eclipse were summarized and framed. This study has shown that the ancient rainfall prediction didn't match with the observational rainfall when small showers of rainfall are predicted in the ancient prediction method. Our study mainly revealed that, rule 4 and rule 5 outnumbered other rules. The Ancient Sanskrit text based rainfall prediction agrees well with the IMD rainfall observations particularly for rule 4 and rule 5 when the rainfall is seen at different regions simultaneously and uniformly distributed over a larger spatial domain.

Keywords:

Weather Prediction, Bruhat Samhitha, Planetary position, IMD rainfall

Introduction

Rainfall is the precipitation which comes down to earth from the sky forming the source of ground water and agriculture where India's economy mainly depends on. So, it is very much important to predict the rainfall. The practise of predicting the rainfall has been available from times immemorial. The ancient Babylonians used to predict the weather based on the cloud patterns and astrology around 650 B.C. The Greek scriptures also used to predict in the similar way. The ancient weather prediction mentioned in the book Meteorological written by Aristotle included the theories of rain formation, clouds, hail, thunder and hurricanes. To predict the seasonal weather, the Chinese astronomers had divided the calendar year into 24 festivals in which each festival is associated with a different type of weather. The forecast signs of the weather were explained comprehensively in the "book of signs" (Theophrastus). The weather prediction methods were also developed by Indian Astronomers that can be found at Pingree, 2014. The weather

prediction in the olden days over India was made by making use of some indicators which include bio-indicators (birds, animals, frogs, etc.,), meteorological indicators (wind patterns, cloud pattern recognition) and astronomical indicators (planetary positions, conjunction of two or more planets). The study made over Manipur listed 25 bio-indicators for weather forecasting (Chanu et al, 2019). The ancient weather forecasting is mainly based on either the computation of the planetary positions & conjunction of planets and starts or based on meteorological/ biological/phonological changes (Mishra et al, 2002). Some combinations of the planetary positions may either provide copious or scanty amount of rainfall or moderate amount of rainfall. This method which was widely followed in ancient days is also being followed in some places to estimate the trends in rainfall despite the development of sophisticated instruments (ground based and satellite) for weather observations and models for weather prediction. The detailed and comprehensive study made by Vanadeep et al, 2012 compared the ancient ways of rainfall prediction with in-situ rain gauge observations on seasonal and annual time scales using in-situ rain gauge observations over Andhra Pradesh. Whereas, in this study an attempt has been made to compare and validate the rainfall predicted using ancient method particularly during the occurrence of eclipse with the rainfall observed using modern instrumentation data obtained from Indian Meteorological Department (IMD).

This paper is organised as follows: Section 2 deals discusses the Ancient Sanskrit based texts and the summary out of it for rainfall prediction (ancient weather forecast data) and IMD daily gridded rainfall data. Section 3 mainly discusses the results obtained from comparing the traditional way of prediction with the modern instrument rainfall observation. This is followed by summary and conclusions.

1. Ancient Sanskrit Literature

In this study, the rules for rainfall prediction during eclipse were obtained from Rahucharadhyaya of Bruhat Samhita which is great work of literature comprising of nearly 4000 verses (*slokas*). This was followed widely by most of the astronomers and it comprises the principles linking the changes in the astronomical aspects with the changes in human life and weather patterns. Though there are many astronomical principles/rules which predict the rainfall only 5 slokas which predict the rainfall during eclipse were considered. These 5 verses

were considered as 5 rules and are mentioned as rule1, rule2, rule3, rule4 and rule5. The five verses representing 5 rules are as follows

Rule1:

काश्मीरकान् कौशलकान् सपुण्ड्रान् मृगांश्च हन्याददपरान्तकांश्च।
ये सोममपासस्तांश्च निहन्ति सौम्ये सुवृष्टिकृत् क्षेमसुभिकक्षकृच्च।।

Rule2:

पौषे द्विजक्षत्रजनोपरोधः ससैन्धवाख्याः कुकुरा विदेहाः।
ध्वंसं व्रजन्त्यत्र च मन्दवृष्टिं भयं च विन्द्यादसुभिक्षयुक्तम्।।2।।

Rule3:

माघे तु मातृपितृभक्तवसिष्ठगोत्रान् स्वाध्यायधर्मनिरतान् करिणस्तुरङ्गान्।
वाङ्गाङ्गकाशिमनुजांश्च दुनोति राहुर्वृष्टिं च कर्षकजनाभिमतां करोति।।3।।

Rule4:

चैत्र्यां तु चित्रकरलेखकगेयसक्तान् रुपोपजीविनिगमज्ञहरिण्यपण्यान्।
पौण्ड्रोड्रकैकयजनानथ चाश्मकांश्च तापः स्पृशत्यमरपोऽत्र विचित्रवर्षी।।4।।

Rule5:

आषाढपर्वण्युदपानवप्रनदीप्रवाहान् फलमूलवार्तान्।
गान्धारकाश्मीरपुलिन्दचीनान् हतान् वदेन्मण्डलवर्षमस्मिन्।।5।।

The summary of the above five rules has been made and is shown in Table1.

No	Name of the Masa	Rain Quantity	Rule number
1	Margasira	Good Rain	Rule 1
2	Pushya	Small Showers	Rule 2
3	Magha	Plenty of Rain	Rule 3
4	**Chitra**	Rain in some parts	Rule 4

5	Ashada	Rain Evenly Distributed	Rule 5

Table1: Summary of Ancient Sanskrit rules observed from Bruhat Samhita

IMD Gridded Rainfall Data:

The daily gridded rainfall data available from India Meteorological Department (IMD) has been used in the present study for comparing and verifying the rainfall predicted based on the rules of the Ancient Sanskrit literature. This data is available at a horizontal resolution of 0.25oX0.25O in latitude and longitude.

The original data set was generated for the period 1901-2010 using the rainfall data available from the rain gauge stations over entire India. As the density of the rain gauge stations is not uniform throughout the country, the rainfall data collected from these rain gauges over different locations of Indian region is interpolated to 0.25° X0.25° resolution. The type of interpolation used and the quality controls applied in generating the gridded data can be found from (Pai et al., 2014; Shepard, 1968). This Two-dimensional (2D) data which was arranged in 135X129 grids starts at 6.5°N & 66.5°E and terminates at 38.5°N & 100°E. The yearly data file includes 365 and 366 records for non-leap and leap years respectively. In the present study, the daily rainfall during the period 1985-2015 has been considered.

Results and Discussion:

All the eclipses (both Solar and Lunar) which had occurred during the period 1985-2015 were obtained to check the traditional rainfall prediction with the instrumental (rain gauge) observations. A total of 132 eclipses had occurred during this period which includes 62 solar eclipses and 70 lunar eclipses. The dates of the eclipses were obtained from the websites (https://eclipse.gsfc.nasa.gov/solar.html and https://eclipse.gsfc.nasa.gov/lunar.html) and these were compared with the eclipse dates obtained based on astrology and found to be same. In this study, the eclipse days whose visibility is seen over Indian region are only considered. The statistics of the eclipse visibility over Indian region for both the eclipses together is shown in Figure 1. The type of eclipse, rule on which the rainfall type is predicted in Ancient Sanskrit scriptures is tabulated in Table 2. There are different types of solar eclipse namely

Total, Annular, Partial and Hybrid and different types of lunar eclipses namely Total, Penumbral and Partial. In this study, the verification of rainfall occurrences is based on the eclipse occurrence over Indian region irrespective of the eclipse (solar and lunar) and irrespective of the type of eclipse. The verification of ancient way of rainfall prediction during different types of solar eclipses and lunar eclipses is beyond the scope of present study.

A day is considered to rainy day if the rainfall intensity over a location is more than 2.5mm. The details related to type of rainfall (light rain, moderate rain, rather heavy rain, very heavy rain etc.) based on the rainfall intensity can be found from the glossary of IMD in the website https://www.imdpune.gov.in/Weather/Reports/glossary.pdf.

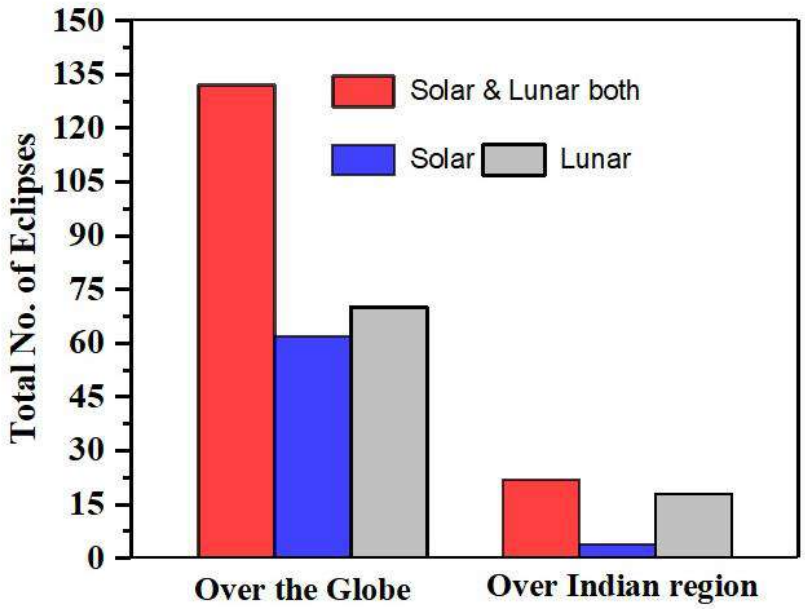

Figure 1: Histograms show the number of eclipses occurrences over the globe (left) and occurrences of eclipses with visibility over Indian region during the period 1985 and 2105.

Out of 132 eclipses, 21 eclipses are only visible over Indian region. These 22 eclipses include 17 lunar and 4 solar eclipses. The percentage of occurrence of the different Ancient Sanskrit rules (rule1 to

rule 5) of these days with respect to the total eclipse that occur over Indian region is shown in Figure 2. From this figure, it is clear that rule 4 and rule 5 occur majority of times compared to other Ancient Sanskrit rules. The comprehensive comparison and validation of these rule based prediction with instrumental observation from Indian Meteorological Department (IMD) during the period 1985 and 2015 is shown as an example for these 5 Ancient Sanskrit rules and represented in Figure 3.

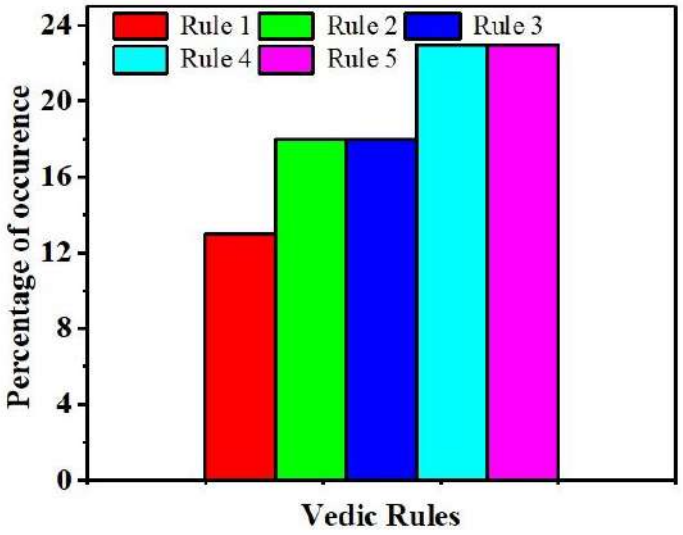

Figure 2: Bar plots show the frequency of occurrences of the rules for rainfall prediction during the eclipse whose visibility is seen over the Indian region for the period 1985-2015.

The spatial distribution of the rainfall that had occurred on 2011-12-10 also coincided with the rule 1 of Ancient Sanskrit text based rainfall prediction (Figure 3 (a)). On this day, the rainfall had occurred over only some regions of Southern India and the rainfall intensity over Tirupathi (13.6˚ N, 79.4˚ E) is ~12mm which falls under moderate rainfall category. There is almost no rainfall over entire India on 2001-01-09, except a few traces of rainfall were observed over the eastern part of Gujarat (Figure 3(b)). Small showers predicted as per Ancient Sanskrit rule 2 on this day almost didn't match with actual rainfall observations. This could be due to the poor horizontal resolution of the data or the rainfall has not really occurred on this day. This aspect has to be studied

in detail by taking long term observations over a particular location.

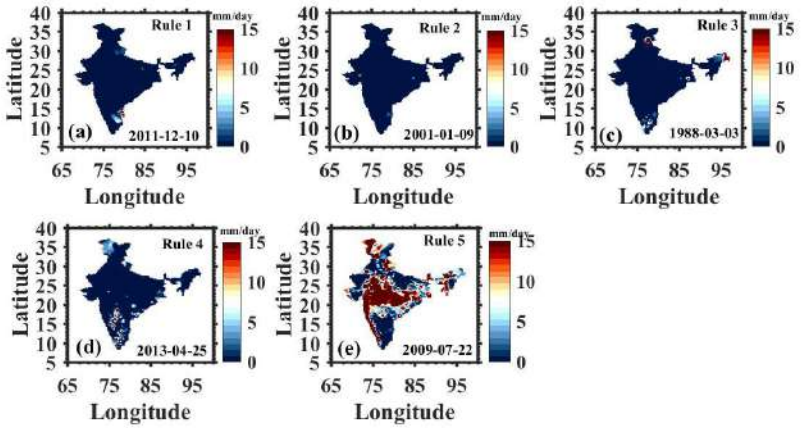

Figure 3: Spatial distribution of rainfall intensity obtained from IMD gridded rainfall data for different Ancient Sanskrit based rules over Indian region during different eclipses for the period 1985-2015.

As per Ancient Sanskrit rule3, on 1988-03-03, plenty of rainfall is predicted. Figure (3(c)) also showed the occurrence of rainfall but only at some regions of South India, Jammu and Kashmir. The intensity of the rainfall occurred over these regions is ~10-12 mm/day will come under moderate rainfall category. The IMD rainfall data showed scattered rainfall on 2013-04-25 (Figure 3(d)) which also coincided with the rule 4 prediction. The rainfall data obtained on 2009-07-22 shows evenly distributed rainfall over larger area which also coincides with the rule 5 of the Ancient Sanskrit astrological rainfall prediction. Thus with the available observations, we could find that the ancient way of rainfall prediction matches well particularly when the rainfall intensity is more and widely spread.

.No	Date of Eclipse	Ancient Sanskrit Rule	Astrological Rainfall Prediction
1	24-04-1986	Rule 4	Rain in some parts
2	03-03-1988	Rule 3	Plenty of rain
3	20-02-1989	Rule 2	Small Showers
4	26-07-1991	Rule 5	
5	31-01-1999	Rule 2	Small Showers
6	11-08-1999	Rule 5	Rainfall Evenly Distributed
7	16-06-2000	Rule 5	Rainfall Evenly Distributed
8	01-09-2001	Rule 2	Small Showers
9	05-06-2001	Rule 5	Rainfall Evenly Distributed
10	15-03-2006	Rule 3	Plenty of rain
11	29-03-2006	Rule 4	
12	04-03-2007	Rule 3	Plenty of rain
13	09-02-2009	Rule 3	Plenty of rain
14	22-07-2009	Rule 5	Rainfall Evenly Distributed
15	31-12-2009	Rule 1	Good rain over a location
16	15-01-2010	Rule 2	Small Showers
17	21-12-2010	Rule 1	Good rain over a location
18	10-12-2011	Rule 1	Good rain over a location
19	25-04-2013	Rule 4	Rain in some parts
20	15-04-2014	Rule 4	Rain in some parts
21	04-04-2015	Rule 4	Rain in some parts

Conclusion:

The rainfall predicted based on 5 astrological rules related to eclipse (solar and lunar) is compared with the IMD rainfall observations over Indian region. The ancient of rainfall prediction agrees very well when there is evenly distributed rainfall over larger spatial domain (rule 5) followed by scattered rainfall (rule 4), good rain (rule 1) over a particular location. However, the Ancient Sanskrit rule 2 and Ancient Sanskrit rule 3 didn't match with the actual observations which could be due to poor horizontal resolution of the data or the rainfall has not at all occurred. A To address this a work is already initiated to compare the rules mentioned here with surface based in-situ rain gauge observations over a particular location rather than looking spatially. In addition, to this the Ancient Sanskrit rule based prediction will also be validated and compared for different types of lunar and solar eclipses over not only Indian region but globally using satellite and computational methods.

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